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Rethinking Figurative Language in Autism: What Evidence Can We Use for Interventions?

Mila Vulchanova and Valentin Vulchanov*

Language Acquisition and Language Processing Lab, Norwegian University of Science and Technology, Trondheim, Norway

Problems with the processing and understanding of figurative language have been systematically observed in individuals on the autism spectrum despite preserved structural language skills. In this qualitative review we discuss theoretical considerations of relevance for figurative language processing in neurotypical individuals and individuals with autism across the life-span. We address the factors which influence figurative language processing and their role in the processing of different types of figurative language, with a focus on idioms and metaphors. We address critically the evidence from research, including findings in our own research and recent systematic reviews and the extent to which they offer a reliable picture of potential deficits in figurative language processing in autism and their possible sources. This evidence is discussed from the point of view of insights it offers for interventions targeting non-literal language skills in children and adults with autism.

Keywords: autism, figurative language, language processing, idioms, intervention, metaphor

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****Correspondence:***
Mila Vulchanova
mila.vulchanova@ntnu.no

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INTRODUCTION

Figurative language is part of the broader notion of formulaic language, most commonly appearing in the guise of multi-word expressions/chunks. According to estimates, multi-word expressions constitute one-third to one-half of daily language routines (Conklin and Schmitt, 2012) and are assumed to aid processing by reducing the load on working memory. Figurative language covers a wide range of phenomena, such as idioms, metaphors, humor, irony, hyperbole. What characterizes these diverse types of expressions is the specific interpretation they invoke. They all represent varying degrees of extending the literal meanings of their constituent words, often leading to interpretations which are non-compositional in nature. A specific challenge in finding common denominators in the processing of figurative expressions and the mechanisms which support it is the fact that different types of figurative expressions have been approached and studied independently, and accounts therefore often target a single type of expression. A further problem in studying their processing in a controlled experimental fashion is the simultaneous possibility for both a literal and a figurative interpretation. For instance, the idiom *Stop pulling my leg* offers both an idiomatic, but also a literal understanding. In a similar way, the idiom *Pull your socks up* is both idiomatically and literally plausible. However, another idiom, such as *I'm a bit under the weather today* only allows for an idiomatic understanding, since the literal one does not appear to make much sense in our physical world. This variation in comprehension possibilities continues to present a challenge both for theoretical accounts and for empirical investigations of this broad range of phenomena.

Despite the diversity, all these expressions are characterized by *indirect reference*, which means that the constituent lexical items stand for some meaning other than the literal. Furthermore, the interpretation is often *not compositional*. The mechanism of retrieving the meaning of figurative expressions is often one which requires additional operations, such as e.g., inferencing based on context (both linguistic and perceptual) and perceiving the intended meaning of the message (speaker's intentions). For example, the comprehension of metaphors requires linking by analogy two concepts which belong to two different domains. In contrast, idioms are usually understood by retrieval from the mental lexicon, i.e., they need to be stored. From the point of view of processing, figurative expressions most likely involve both on-line computation, and lexical access. It is exactly the balance between these two processes, which most theories need to outline.

The diversity and complexity of factors involved in the processing and comprehension of figurative language may be specifically challenging in developmental disorders, such as autism. Problems in this domain are well-attested (Tager-Flusberg, 2006; Volden and Phillips, 2010; Vulchanova et al., 2015), however, their source remains largely controversial.

ACCOUNTS OF FIGURATIVE LANGUAGE PROCESSING

Different accounts have been proposed to explain the on-line processing of idioms as a central exponent of the category of figurative language. According to the *standard pragmatic approach*, the first step in processing involves activating the literal meanings associated with the contsituent words in the expression, only arriving at the intended figurative interpretation at a second step (Grice, 1975). In contrast, the *direct access model* assumes that there is no need for the initial activation of the literal meaning(s) (Gibbs, 1994). Instead, the figurative meaning is retrieved directly, following cues from the linguistic and other (e.g., communicative) context of the expression. The lexical nature of idioms has been recognized also in the *lexical representation hypothesis* (Swinney and Cutler, 1979), where idioms are assumed to be stored as lexical items which can be retrieved fast, at the same time engaging a second parallel process of lexical decomposition. Most current approaches acknowledge the necessity for both literal computations, e.g., involving constituent decomposition, and lexical retrieval. Thus, Hamblin and Gibbs (1999) suggest that idiom interpretation depends on identifying the individual constituents, because most idioms are decomposable. In a similar vein, it has been argued that processing and understanding of idioms cannot be reduced to lexical access or lexical retrieval only (Cacciari and Tabossi, 1988; Gibbs, 1992; Vega-Moreno, 2001). A similar, albeit technically different, approach, is the *configuration hypothesis*, according to which idioms are represented in a distributed way and are processed as complex expressions, very much like other instances of similar syntactic complexity (Cacciari and Tabossi, 1988). In their review of current approaches to idioms, Titone and Connine (1999) suggest a "hybrid" model, which acknowledges both the arbitrary "word" nature and the compositional aspect of idioms. Their model takes into account an important parameter on which idioms vary, namely degree of decomposability, which also constrains the ways in which they can be interpreted. Importantly, the activation of literal meanings associated with the meanings of constituent words has been documented in a number of studies, including priming for idioms and metaphors (Chahboun et al., 2017; Koleva et al., 2019) and in metaphor comprehension (Vega-Moreno, 2007).

Metaphors are another salient type of non-literal language where an association is formed between two seemingly unrelated domains of knowledge (Mashal and Kasirer, 2011). Fauconnier (1985) provides an excellent framework for describing language forms in terms of the underlying conceptual organization and networks which support language use. He refers to Nunberg's (1978) notion of pragmatic function which serves the purpose of reference to one object in terms of another object which may be appropriately linked to it. Establishing links between objects of a different nature is routinely used for psychological, cultural or pragmatic reasons in everyday conversation and is based on the Identification principle. On this principle a reference trigger can be associated with a reference target via a connector function. Metaphor is a par excellence example of the workings of this reference principle. Thus, in *train of thought* the notion of motion suggested by *train* is linked to the process of thinking, and this relationship is mediated by the specific linguistic form of the expression, with both words being part of the same noun phrase. While most scholars agree on the principle of identifying one notion in terms of the other as basic in the case of metaphor creation, different theories have been proposed to explain how metaphors are processed. Thus, it has been suggested that metaphor comprehension depends on the level of conventionality of the expression, with novel metaphors depending on comparison or analogy and conventional metaphors being made available via categorization where the two concepts are members of the same concepatual space/category (Glucksberg, 2001; Bowdle and Gentner, 2005). It has also been suggested that metaphor comprehension may be more inherently related to other processes of language comprehension, and not exclusively based on analogical reasoning. Such accounts invoke the role of context in overall language comprehension and the process of semantic integration, as for instance outlined in the tradition of building a mental model (Kintsch, 2000). Related to this view is the idea proposed by Carston concerning the meaning of metaphorically-used language. On this view, interpretation in such cases involves the "adjustment or modulation of lexically-encoded meaning, which makes it possible for speakers to communicate a vastly greater range of concepts than those that are stably encoded in their linguistic system" (Carston, 2010). Metaphor comprehension has also been claimed to strongly involve mental imagery (Gibbs and Bogdonovich, 1999). However, Carston (2018) provides a convincing argument against this idea.

Studies of neurodevelopmental disorders, such as autism, allow for empricially testing some of the above hypotheses and accounts. Extant research documents that individuals with autism experience problems in the processing of metaphors, however, findings diverge on whether there is an overall problem

in that domain or difficulties apply to a specific category. For instance, Mashal and Kasirer (2011) provide evidence that children with autism (aged 12–15) differ from typical controls on the comprehension of conventional metaphors, but not on novel metaphors. These results are supported in a series of studies by our team (Chahboun et al., 2016a,b, 2017; Vulchanova et al., 2019b). These findings provide support to the career of metaphor account by Bowdle and Gentner (2005) and may suggest that while novel metaphors need to be computed on-line, in all likelihood involving similar processes to literal expressions, conventional metaphors may largely rely on storage. In contrast, Kasirer and Mashal (2014) report no main effect of group in their study of adult participants on the autism spectrum in comparison to neurotypical similarly aged participants. However, their results reveal a main effect of metaphor expression, with better performance by both groups on conventional metaphors relative to novel metaphors. This finding, which is not consistent with the results of the child study by the same authors, points potentially to a developmental trajectory and may indicate that conventional expressions are acquired in the course of development, and that with time, adults may increasingly rely on stored chunks for the purposes of processing. A recent eye-tracking study of idiom processing in the first language by adult native speakers of English confirms this strategy (Milburn et al., in submission).

FACTORS DETERMINING THE PROCESSING OF FIGURATIVE LANGUAGE

The problem in studying figurative language resides in the huge variation between expressions in degrees of *transparency* (decomposability), *extension* from the literal meaning, *conventionality*, and *structure* – from a single word to sentence. Not surprisingly, these parameters of variation have been identified in research as the crucial factors affecting figurative language comprehension and on-line processing. Among those, degree of decomposability, sometimes called transparency, and degree of conventionality/novelty feature as central. Decomposable expressions [e.g., *go downhill* (deteriorate); *get wet to the bones* (soaking wet)] invoke interpretations which are closely associated with the literal meanings of their constituent words. Thus, accessing the key words in such expressions can lead to the activation of the associated figurative interpretation by extension. Non-decomposable expressions are non-transparent in that none of the constituent lexical items or their meanings can lead to the target interpretation. Thus, *a red herring* (a distraction/false lead) cannot be processed based on co-composing the adjective ≪red≫ and the noun ≪herring≫. Such expressions are typically stored in the mental lexicon with the figurative meaning and need to be acquired in appropriate contexts. Decomposability has been shown to affect both the on-line and off-line processsing of idioms. While greater transparency/decomposability typically leads to better off-line comprehension (Gibbs et al., 1989; Libben and Titone, 2008; Chahboun et al., 2016b), it may interfere with priming and lead to decreased priming effects on-line. In addition, decomposable idioms may be more easily acquired than non-decomposable idioms, as reflected in the results by Cain et al. (2005). In that study, poor comprehenders had problems in the interpretation of non-decomposable idioms, but not with decomposable ones. Also, in a study of idiom knowledge across the lifespan, Sprenger et al. (2019) found that idioms with low decomposability scores were rated as less familiar than items with high decomposability scores. Interestingly, this effect was restricted to the younger raters (<40 years old) in the study.

Degree of conventionality/novelty is another important factor which may affect the processing of figurative expressions. Among idioms, the less decomposable/transparent expressions are the result of conventionalised language use tightly linked to specific contexts where the figurative meaning is appropriate. Conventionalisation leads to loss of the original semantic motivation of the expression, and increased lack of transparency, whereby the expression is arbitrarily associated with a specific interepretation, very much like lexical items (e.g., items that need to be stored in the mental lexicon by virtual necessity, Jackendoff, 2002). The distinction between novel and conventional is relevant also for metaphors. An open question is which of the two types, novel or conventional metaphors, lead to better processing performance in typical individuals. While some studies argue that conventional metaphors tend to improve performance as a result of their figurative meaning being more salient and familiar along the lines of the graded salience hypothesis (Giora, 2009; Vulchanova et al., 2012), other studies document that between the two types, novel metaphors are processed faster and more successfully, due to their transparency (Chahboun et al., 2016b, 2017; Kasirer and Mashal, 2016). Furthermore, novel metaphors do not depend on stored vocabulary knowledge beyond the meaning of their constituent words and are more likely to be computed on-line. As a matter of fact, the processing and comprehension of novel metaphors can be used as a baseline for comparison with idioms and other figurative expressions (Chahboun et al., 2016b).

While conventional metaphors tend to be more familiar, novel metaphors are less familiar (Giora and Fein, 1999). The graded salience hypothesis makes specific predictions concerning the processing of familiar conventional metaphors contra novel metaphors. While conventional metaphors are expected to be processed similarly to literal language due to salience of the respective meanings (figurative or literal), the processing of novel metaphors would need to recruit more resources in order to arrive at the intended metaphorical meaning, which in the latter case, is non-salient (Giora and Fein, 1999; Mashal et al., 2005; Giora, 2009). The differential processing of novel and conventional metaphors has also been claimed to differentially recruit distinct hemispheres and neural networks (Mashal et al., 2005, 2013). The difference in processing between conventional and novel metaphors is indeed well-attested in behavioral data, and argued from different theoretical perspectives (Gentner, 1983; Bowdle and Gentner, 2005; Giora, 2009). However, an open question is how both types of metaphor compare to literal expressions and their processing. Since both literal expressions and novel metaphors must rely on initial retrieval of the meanings associated with the constituent words, and

subsequent operations on those meanings (composition in the case of literal expressions, and analogy, in the case of novel metaphors), we would expect that they might elicit comparable (and longer) processing latencies. In contrast, the target non-literal meaning of conventional metaphors is most likely directly retrieved from the long-term storage component. Indeed, studies comparing literal language to non-literal metaphorical language demonstrate gradient processing load between literal expressions and novel metaphors, whereby the factor that impacts on brain responses to the stimuli, in addition to metaphoricity, is *cloze probability* (Coulson and Van Petten, 2007). In the study by Coulson and Van Petten (2007), compared to high-cloze literal expressions, low-cloze literal expressions elicited a larger N400 in both hemispheres, as well as a larger frontal positivity following the N400 in the left hemisphere, indicative of a greater processing load. In comparison to low-cloze literals, low-cloze metaphorical expressions elicited more negative ERPs during the timeframe of the N400 and afterwards, suggesting a gradience in processing load across expressions. Similarly, the study by Vulchanova et al. (2012) attests a gradience between response latencies to literal expressions, conventional and novel metaphors, where conventional metaphors elicit the fastest responses, followed by literal (free) expressions, and novel metaphors. However, the distinction between conventional and novel metaphors was maintained, with a significant difference in reaction times ($p = 0.005$), coupled to a significant difference in accuracy ($ps < 0.001$).

Conventionality/novelty often correlates highly with other factors, such as e.g., familiarity and frequency. However, there is no consensus on what test can be used as an objective measure of familiarity and how it can be operationalised (cf. Thibodeau et al., 2018 for a discussion). While some authors have used subjective measures, such as e.g., ≪the perceived experience with the metaphor≫ (Blasko and Connine, 1993), others suggest that frequency (measured in web corpora) can be used as an objective measure due to its high correlation with familiarity (Thibodeau and Durgin, 2011). In addition, conventionality and familiarity often do not yield clear independent effects in experimental research (Dulcinati et al., 2014).

The study by Coulson and Van Petten (2007) is important in another respect. Their data suggest that both cerebral hemispheres can benefit from supportive sentence context, highlighting the relevance of context in the processing of figurative language. Thus, context has been identified as crucial in the comprehension of a wide range of figurative expressions. Supportive context allows for inferencing and deriving the communicative intent of the expression. For this reason, most studies of figurative language include either linguistic or visual context, or both.

In a recent theoretical discussion of idiom processing across populations of speakers, Vulchanova et al. (2019a) provide a detailed assessment of the factors which support idiom comprehension and which among these factors conspire to create a bias for literal interpretation over the target figurative one. The authors propose that collocational frequency of the key idiomatic word (e.g., measured as cloze probability) can interfere with idiom processing depending on the collocational frequencies of literal fillers competing for the same position in a free literal context. Thus, two main factors emerge as crucial in constraining the interpretation of idioms: *collocational frequency* as an idiom-internal factor, and (biasing) *context*, as an idiom-external one. This is what two recent studies set out to explore. Milburn et al. (2021) and Milburn et al. (in submission) examined the relationship between the collocational frequency of idioms' component words and the context in which an idiom is embedded in two populations of users. In a visual world eye-tracking study, advanced non-native English speakers and native language speakers heard incomplete English phrases embedded within contexts that biased either literal or idiomatic continuations and saw images representing literal or figurative completions, or distractor images. In contrast to the native speakers, the non-native speakers showed a bias toward compositional processing with heightened interference from high-cloze distractors, congruent with evidence showing that non-native speakers are broadly sensitive to frequency information during multiword phrase processing. In addition, the native speakers displayed early albeit shorter looks toward the image corresponding to the figurative target even in the literally-biased condition. Taken together, these findings suggest that adult native speakers rely on lexical access for idioms, in all likelihood, as a result of highly automatized language processing, while L2 speakers are more likely to also consider possible literal alternatives, as seen in the interference of the high-cloze distractor even in figurative contexts.

FIGURATIVE LANGUAGE PROCESSING IN AUTISM AND METHODOLOGICAL ISSUES

Autism is a neurodevelopmental disorder characterized by communication and social deficits and restricted and repetitive patterns of behavior (DSM 5). The autism spectrum offers a wide range of variation on a number of scales, including both intelligence and language competence, in addition to degree of symptom severity. The attested heterogeneity in the condition involves multiple etiologies, sub-types, and developmental trajectories (Masi et al., 2017). Structural language competence on the autism spectrum can vary from minimally verbal, on the lower end of the spectrum, to highly verbal on the higher end, where structural language skills (phonology, morphology and syntax) are preserved (Tager-Flusberg, 2006; Vulchanova et al., 2015). Highly verbal individuals with autism are distinguished by relative preservation of both cognitive and linguistic skills. Still, problems with pragmatic aspects of language have been consistently reported across the autism spectrum (Volden and Phillips, 2010; Ramberg et al., 2011). Recent studies provide evidence of failure to understand pragmatic, non-literal aspects of language, such as metaphors, idioms and other forms of figurative language, even when structural language may appear to be intact (Gold and Faust, 2010). Vulchanova et al. (2015) offer a comprehensive critical review of converging evidence from existing research, while Morsanyi et al. (2020b) and Morsanyi and Stamenkovi (2021) offer well-designed systematic reviews,

respectively of metaphor comprehension, and idiom and proverb comprehension in autism.

The most intriguing question concerning the comparison between typical individuals and highly verbal individuals with autism is whether the well-attested problems in the processing of figurative language arise from the autism symptomatology or are rather related simply to level of language competence. One popular account suggests that the commonly observed problems with figurative language comprehension are due to specific features of autism, such as deficient theory of mind (Happé, 1995) or weak central coherence (Martin and McDonald, 2003; Happé and Frith, 2006; Le Sourn-Bissaoui et al., 2011). Other accounts attribute those problems to immature linguistic skills (Gernsbacher and Pripas-Kapit, 2012) and/or impaired semantic abilities (Norbury, 2005). Indeed, evidence has been provided in support of both types of account. However, it is often difficult to compare studies and their results due to differences in the measures used for the analyses, the stimuli and categories of figurative expressions used, the age and size of the sample, as well as the language descriptors of the participants. For the very same reason, it is often difficult to conduct meta-analyses on existing studies. An exception are two recent excellent systematic reviews of research in the domain of figurative language in autism. Morsanyi et al. (2020b) reviewed evidence of metaphor processing based on well-chosen criteria. For the review and meta-analysis, they selected only studies where participants were matched on chronological age and verbal or full-scale IQ, thus avoiding confounds arising from the absence of a clear baseline for group comparison. The aim of the systematic review was to address critically a common claim in research in that domain, namely that problems with figurative language are the direct consequence of problems in other domains of language competence in autism, and that these problems will disappear once groups are matched on language and intelligence. This review demonstrates convincingly that carefully matched participants with autism systematically underperform on metaphor tasks when matched to controls and provides evidence of a medium-to-large group difference favoring TD over ASD groups based on accuracy measures, as well as a similar overall advantage for TD groups based on reaction times.

An interesting question related to metaphor processing is the extent to which it relies on analogical reasoning skills. Non-verbal analogical reasoning for analogies based on perceptual relations or scene analogies has been identified as a particular strength in autism. Thus, participants with autism often perform at the same level as age- and IQ-matched typically developing individuals on non-verbal analogy tasks, while individuals with autism in the context of learning difficulties display superior performance in comparison to age- and IQ-matched controls (see Morsanyi et al., 2020a, for a systematic review and meta-analysis). Analogical reasoning depends on the ability to establish similarities among entities based on relations, rather than the features of entities (Gentner, 2010; Holyoak, 2012; Holyoak and Lu, 2021). Thus, it requires both flexibility and abstraction, instead of e.g., focusing on specific details. Further evidence suggests that participants with autism can perform well on analogical reasoning, even in the presence of distractors, and the strategies used to solve analogical reasoning problems appear to be similar to the strategies used by typically developing individuals (cf. Morsanyi and Holyoak, 2010). While this adds a further dimension to the puzzle of the mechanisms that support figurative language processing, the evidence of an analogical reasoning advantage can benefit intervention designs for children and adolescents with autism, specifically in the domain of metaphor comprehension.

Morsanyi and Stamenkovi (2021) provide a systematic review and meta-analysis of studies of idiom and proverb processing in autism. In contrast to metaphors, idioms and proverbs are types of figurative language which are more conventionalized and frequently less decomposable than metaphors, pointing to a difference in their processing in conversational contexts (Vulchanova et al., 2011). The review and analysis encompassed a total of 11 studies from 10 papers (involving 235 autistic and 224 TD individuals), which met the inclusion criteria of matching on both chronological age and intelligence. The analysis of accuracy data revealed a group difference favoring the typically developing individuals over the ASD groups, with a medium effect size. Importantly, there was no indication of a publication bias. Participants' age was unrelated to the magnitude of group differences, but there was a trend for smaller group differences in the case of participants with higher (verbal) intelligence.

Methodologically, there are two viable strategies to avoid the confounds common to research of this type. One possibility is to match experimental and control groups on a number of independent variables: age, intelligence, and critical language measures. Thus, possible emerging differences between the groups in figurative language comprehension will be attributable to group belonging only. While this approach may appear relatively safe, a problem is reducing inter- and intra-group variability. Alternatively, the design can aim to ensure greater variability in the autism sample on a number of language measures (grammar, including both morphology and syntax; semantics; phonology and semantics). In addition, measures of autism symptomatology need to be included, such as performance on Theory of Mind (ToM) tasks, and psychometric instruments. All of these measures can then be linked to the experimental variable(s), namely performance on a figurative language task or alternatively included in models as additional factors, which allow for examining their impact on the variables of interest. The analyses will demonstrate which of these skills better predict performance on figurative language. One problem with this type of design is that it is hardly likely to find a control group with the same type of variation in, and level of, language competence. In addition, level of intelligence will often co-vary with language competence, and lower levels of language skills in autism will often be associated with lower IQ scores, again making it difficult to match with controls. One way out would be to control for co-morbidity with language impairment in the autism group, by including an atypical group where only language is impaired, such as e.g., participants with developmental language disorder and a group of autism participants where no structural language problems are apparent (e.g., highly verbal participants with ASD). This approach was

used by Norbury (2005) who found that the best predictor of metaphor comprehension in children with impaired language with or without autism was semantic ability. However, other studies document figurative language comprehension problems regardless of semantic skills. In a study of highly verbal individuals with autism, Dennis et al. (2001) found that while the participants did not have semantic problems which were assessed on attributing different meanings to ambiguous words, they had serious problems in the interpretation of idioms and metaphors. These results may rather suggest a subtle dissociation between structural language as well as core semantic skills, on the one hand, and figurative language abilities, on the other. A recent study of elicited production of passive morphology by children with autism in comparison to IQ matched controls supports this idea (Ambridge et al., 2021). In that study the children with autism produced accurately passive morphology, but made errors in the thematic role match and performed reversal errors when mapping the verb arguments to syntax, suggestive of a dissociation between structural aspects of language and phenomena at the interface between grammar and semantics/pragmatics.

Alternatively, the results may be attributed to inability to infer the intentions of the speaker (Melogno et al., 2012a), or deficient Theory of Mind (ToM) ability, as argued by Happé (1995). The ToM lead is further supported in a study of primary-school children with ASD by Huang et al. (2015). That study found differences in the ability to comprehend metaphors among the children with autism between those with and without the ability to respond to first-order ToM tasks. However, unlike other figurative language, metaphor comprehension was also related to verbal abilities in this group. Other interpretations highlight the need to consider context when interpreting figurative language. From this point of view, poorer interpretation of figurative language by individuals with autism could result from weak central coherence, i.e., a cognitive bias toward processing local items of information, including components of figurative expressions, in isolation of each other and from linguistic and social context (Loukusa and Moilanen, 2009).

It has been demonstrated in several studies that the comprehension of idioms and metaphors (both conventional and novel) with or without contextual support in individuals with autism lags behind what is typical of their chronological age (Norbury, 2004; Melogno et al., 2012a,b; Vulchanova et al., 2012, 2015; Olofson et al., 2014; Whyte et al., 2014; Huang et al., 2015; Chahboun et al., 2016b). Thus, age becomes an important variable in assessing figurative language competence in autism. In our own research (Chahboun et al., 2016a,b, 2017; Vulchanova et al., 2019b) we have documented a different developmental trajectory in the autism groups whereby the adult group with autism performed at the level of the control children. Furthermore, we found that even though language skills may predict performance on figurative language in both the autism and control groups, the specific language measures differed between participants with autism and controls. These results align with the findings in Huang et al. (2015) where ToM only predicted performance in the autism, but not in the control group.

While most current research has focused on the comprehension of figurative language in autism, studies of figurative language production in that population are still limited. Mashal and Kasirer (2011) provide evidence of metaphor generation in adults on the autism spectrum. In that study the participants with autism generated more creative metaphors than the control group. Importantly, performance on this task was predicted by scores on a test of non-verbal intelligence.

Kasirer and Mashal (2016) investigated comprehension and production of metaphors in children with autism (age range 9–16) in comparison to age-matched peers. While no group differences were observed in the novel metaphor comprehension task, the group with autism understood fewer conventional metaphors than their TD peers. Interestingly, whereas participants with ASD generated less conventional metaphors, they generated more creative and novel metaphors.

Such findings may reflect an interesting asymmetry between comprehension and production of figurative language in autism, with largely impaired comprehension, but intact, and perhaps even enhanced, production. This may be taken as evidence of greater creativity overall in individuals with autism (Kasirer and Mashal, 2014). To what extent this applies to all categories of figurative language and across different verbal ability-groups should be confirmed by future research. In addition, the extent to which figurative language produced by participants with autism is processed appropriately by neuro-typical individuals should be tested as well.

The gap in research on figurative language production may be due, among other things, to the complexity of factors and mechanisms underlying figurative language expressions, which, in turn, makes the creation of adequate testing designs more difficult. Problems with experimental design alignment are endemic to the field, as observed in a number of qualitative and systematic reviews of the field. In addition, the creation of production designs which elicit targeted production of a specific language or communication phenomenon is more subtle and difficult to achieve (cf. discussion in Ramos-Cabo et al., 2021).

POSSIBLE ACCOUNTS AND THEIR EVIDENCE

The heterogeneity of the autism spectrum condition and the range of factors which impact on the processing and comprehension of figurative language present a serious challenge for identifying the causes of the well-documented problems in that domain in individuals on the spectrum, and for providing a well-informed account. In our own research we have adopted a methodology for studying highly verbal individuals with autism carefully matched on age, IQ, and language comprehension to neuro-typical controls. This design allows for a reliable comparison between participant groups on performance on selected figurative language tasks. In a series of studies we have tested whether metaphors, when presented in appropriate context, prime their figurative interpretation using a lexical decision task (Chahboun et al., 2016a, 2017); whether individuals with autism select the target figurative meaning of idiomatic

expressions using reaction latency and accuracy measures (Chahboun et al., 2016b), and eye- and hand-movements (Vulchanova et al., 2019b), and the strategies underlying text comprehension in participants with autism by using eye-tracking methodology (Micai et al., 2017). In those studies, we were also interested in uncovering possible developmental trajectories, especially in the participants with autism compared to controls. For this reason, the studies recruited two age groups of participants, children in the age range 10–12 years, and young adults in the range 16–22 years in a cross-sectional design.

The main findings in those studies can be summed up in the following way. The main problems encountered by the participants with autism were primarily reflected in significantly greater reaction latencies in comparison to controls. The participants with autism sometimes performed at adequate levels of accuracy, but still under-performing in comparison to controls. Another major finding is the difference in developmental trajectories between the experimental groups and controls. Thus, young adult participants with autism performed at the level of control children, but better than children with autism, as evidenced by main effects of Age and Group in our analyses. We also have evidence of different underlying strategies in the processing of figurative language and in text comprehension. Below we address each of these findings and their consequences for possible accounts of what might be causing the problem.

The study by Chahboun et al. (2017) aimed to establish the processing of three types of expressions, novel and conventional metaphors compared to literal (non-metaphorical) expressions. It was designed as a cross-modal lexical decision task where the expression of interest for the study (novel metaphor: conventional metaphor: literal expression) served as the prime, and participants made lexical decisions on a target (word or non-word). The target words were semantically related to the prime expressions by either figurative or literal association. This study documented significant differences in reaction latencies (one-way ANOVA and *post-hoc* comparisons with Bonferroni correction), where the control young adults responded significantly faster than the control children ($p = 0.001$, $d = 1.473$) and the ASD young adults ($p < 0.001$, $d = 1.103$). Furthermore, the control children and the ASD young adults showed comparable speed in responding. Similarly, in Chahboun et al. (2016b) the overall linear mixed model analysis revealed differences in reaction latency for Age (children/young adults) [F (1, 82.64) = 20.38, $p < 0.001$] and Group (control/ASD) [F (1, 86.85) = 10.64, $p = 0.001$], with slower responses by children and individuals with autism.

Concerning accuracy as an off-line measure, the overall linear mixed model in Chahboun et al. (2016b) revealed significantly more errors in the participants with autism compared to controls [χ^2 (1, 23) = 11.21, $p < 0.001$]. In addition, a two-way interaction between age and group was observed [χ^2 (1, 23) = 4.98, $p = 0.025$], driven mainly by the differences between young adults (ASD and controls) ($p < 0.001$), and between the two control groups (children and young adults) ($p = 0.01$). However, no differences were observed between the two autism groups ($p = 0.99$) or children (ASD and controls) ($p = 0.74$). These results suggest that participants with autism perform at the same level in selecting the correct target figurative meaning regardless of age.

One important and novel finding is the evidence of a possible developmental trajectory in the autism groups in our experiments. We included children around the age when figurative language skills take off (Levorato and Cacciari, 1995; Nippold, 1998; Vulchanova et al., 2011, 2015; Cacciari, 2014) and young adults when figurative language skills appear to stabilize. To the best of our knowledge, these are the first studies targeting age in the assessment of figurative language skills in autism with the possibility of establishing a developmental trajectory in a cross-sectional design. Both studies provide evidence of a developmental lag in the processing of figurative language in autism in comparison to controls, whereby the young adult group with autism performed at the level of the control children group. Chahboun et al. (2017) established, that young adults with ASD performed comparable to the control children group. In addition, the young adults with ASD performed similarly to typical children in not displaying a reaction time difference between literal and metaphorical prime-target pairs, in contrast to the control adult group where a significant difference was observed. Furthermore, Chahboun et al. (2016b) established a similar response pattern for the young adults with autism and the control children on both accuracy and reaction speed. Thus, the specific pattern of processing in autism may be due, in part, to a delayed trajectory in developing the skills necessary to process figurative language. This assumption is further supported by the fact that different core language skills predict performance on the lexical decision priming task in participants with autism and controls (Chahboun et al., 2016a). The results from Pearson's correlations and regression analyses in that study reveal an interesting and complex pattern of relationship between language skills and figurative language competence. Interestingly, significant correlations were found overwhelmingly for the two ASD groups, but not to a similar extent for the two control groups. Furthermore, no significant correlations were observed for any of the groups between ToM scores and any of the independent variables. In the group of children with autism, verbal comprehension significantly predicted performance accuracy, while no significant predictors were found in the other participant groups. Concerning reaction speed, vocabulary size was the most significant predictor in the young adult ASD group, while no significant predictors were establsihed for the other groups. Overall, these findings are consistent with Norbury (2005), who found that semantic skills largely determined metaphorical understanding for participants in her study. However, the absence of a relationship between basic vocabulary, receptive grammar and verbal comprehension and metaphor processing in the control groups is puzzling. It can be speculated, however, that, while the participants with autism are still acquiring both some of the language competences and the ability to process metaphors, the controls are already past the stage where basic language skills continue to exert an influence on figurative language processing.

The above results highlight the issue of interpretation. If young adults with autism are less accurate than young adults

without autism, what might underlie their interpretation? The results in Chahboun et al. (2016b) suggest that they are being more literal. In this study, a difference in degree of literalness was observed in response accuracy. The model revealed a main effect of group (control/ASD) [$(\chi^2(1, 26) = 5.22, p = 0.022]$, with more literal responses by participants with autism, and a marginally significant difference in accuracy between Age (children/young adults) [$(\chi^2$ (1, 26) = 3.51, p = 0.06]. In addition, a two-way interaction between age and group was observed [χ^2 (1, 26) = 4.89, p = 0.02]. Multiple comparisons with Tukey contrasts revealed that this interaction was due to a significant difference between control young adults and young adults with autism (p = 0.015), in that the young adults with autism converged on more literal responses than their typically developing peers. These data provide evidence that the younger participants and the participants with autism in our study interpreted the stimuli more often literally than the older participants and the control groups. These findings provide support for extant research on young children and individuals with autism documenting a tendency for literal interpretation (Mitchell et al., 1997). We can speculate that this trend might be due to immature multi-modal information integration skills, leading to problems in considering the communciative and linguistic context of the expression. This assumption concurs with the differences observed in predictors of metaphor processing between controls and participants with autism (Chahboun et al., 2016a). Further evidence of the literal tendency comes from the analyses of gaze behavior and hand movements in Vulchanova et al. (2019b). These data reveal that greater idiom transparency and decomposability might interfere with the correct target figurative interpretation and pulls in the direction of literal compositional parsing rather than the expected idiomatic one. What explains this literalism trend in autism is still open to debate, but an intriguing account is offered in Vicente and Falkum (2021). On this account, the well-observed literal trend on the autism spectrum can be related to rule-following behavior, also observed in younger children. This idea is consistent with the findings in the studies by Vulchanova and colleagues documenting a developmental lag in the participants with autism.

The series of studies we conducted have revealed an intriguing difference between neuro-typical individuals and the participants with autism in the effect of stimulus presentation modality. Chahboun et al. (2016b) document a processing and comprehension advantage for controls when the target expression is presented in the auditory modality, and this advantage applies to the most transparent categories (decomposable idioms and novel metaphors). Thus, it appears that typical controls perform better in the oral language modality. No such trend was observed in the ASD group, suggesting a difficulty, even in highly-verbal individuals with autism, in multimodal information integration, even when the idiomatic expressions are decomposable (cf. also Ozonoff and Miller, 1996). These differential responses to modality in the autism group may be indicative of different processes or mechanisms in the resolution of figurative expressions, or different approaches when attempting to respond to the task. This finding is also consistent with the idea of a residual oral language problem also in individuals with intact structural language skills, and with Eigsti (2013), where the deficits in autism are attributed to low-level impairments in generic cognitive and processing mechanisms.

In addition, Chahboun et al. (2016b) showed interesting differences between participant groups and modalities of stimulus presentation (auditory vs. visual/orthographic) for each type of expression (transparent/non-transparent idiom and novel metaphors). With increase of expression non-transparency, the advantage of modality changed only for controls. For controls, transparent expressions were processed faster in the oral modality and less transparent expressions were processed faster in the orthographic modality. However, no such trend was observed for the participants with autism. The longer response latencies observed in those studies for the participants with autism are indicative of greater processing demands and potential problems in making decisions on figurative expressions. A possible explanation of these findings is that the figurative non-literal nature of the expression interferes with a competing literal interpretation leading to longer reaction times. This potential account is consistent with the gaze and hand movement results in Vulchanova et al. (2019b). It also aligns with the range of approaches to figurative language processing which assume simultaneous activation of the constituents (e.g., decomposition), while at the same time suppressing or inhibiting the literal interpretation in favor of the target figurative (non-literal) meaning of the expression. Furthermore, the interaction between modality of presentation and expression transparency only evident in the control groups may be indicative of a different figurative language processing pattern in autism. Similar results were obtained in Vulchanova et al. (2012) in a case study of a young adult with Asperger's syndrome, where unlike controls, the case participant did not differentiate between novel metaphors and non-sense expressions, as reflected in his response times.

Both Chahboun et al. (2016b, 2017) thus document that type of expression impacts differentially on processing and comprehension. Many of the analyses reveal a main effect of type of expression, where decomposable (transparent) idioms and novel metaphors are easier to process than non-decomposable expressions (idioms and conventional metaphors). More importantly, even though the participants with autism in those studies were significantly slower in comparison to controls, they displayed similar patterns of difficulties and ease across experimental categories as the control groups. These results lend support to approaches to figurative language (e.g., the hybrid approach, Hamblin and Gibbs, 1999; Titone and Connine, 1999) which recognize the diversity of expressions highlighting the factors which affect their processing, with decomposability featuring prominently here. This is further evidenced by the main effects of type of expression found in Chahboun et al. (2017). In that study, paired-samples t-tests confirmed that novel metaphors were associated with faster response times ($\overline{x}$ = 1.293, SEM = 0.0413) than conventional metaphors [$\overline{x}$ = 1.255, SEM = 0.0385; t (81) = 2.685, p = 0.009] and that a literal relation between prime and target produced faster responses ($\overline{x}$ = 1.296, SEM = 0.0406) than a metaphorical relation [$\overline{x}$ = 1.251, SEM = 0.0394; t (81) = 2.962, p = 0.004]. These results highlight

an important aspect of the processing of figurative expressions, namely that literal meanings are more likely to be activated when the expression is more transparent/decomposable and lend support to hybrid approaches to figurative language (Cacciari and Tabossi, 1988; Titone and Connine, 1999). We also have evidence that the most transparent type of idioms is more likely to present a challenge in converging on their figurative interpretation on-line, despite accurate off-line responses in highly verbal participants with autism (Vulchanova et al., 2019b).

CONCLUDING REMARKS AND CONSEQUENCES FOR INTERVENTION DESIGNS

Detailed studies of figurative language processing and comprehension in autism and recent systematic reviews and meta-analyses suggest that figurative expressions of different degrees of transparency and novelty/conventionality place heavier processing demands on individuals with autism in comparison to typical controls. The samples in those studies included highly verbal individuals with autism carefully matched to controls on both age and structural language and non-verbal intelligence measures. The observed differences between the participants with autism and controls in both reaction latencies and response accuracy are indicative of problems in the on-line processing and off-line comprehension of a variety of figurative expressions, ranging from highly decomposable/transparent to non-transparent. These results further suggest that, in all likelihood, there is a subtle dissociation between structural language skills on the one hand, and the ability to process figurative language, on the other. Oral language skills obviously play a role in the development of figurative language: adults with autism and good oral language outperform children with less developed language, and important aspects of oral language correlate with figurative language in participants with autism. However, these same adults with autism do not reach the level of performance of adults without autism, although they are closely matched. This suggests that beyond the role of oral language, additional differences in the processing of figurative language by individuals with autism may be found. Figurative language processing and comprehension taxes the language system, but also involves appreciation for the communicative context and the integration of multiple sources of information from different modalities. Some of the results reviewed here demonstrate that this may be the underlying problem in the participants with autism. However, despite the significantly slower response latencies and lower accuracy, they demonstrate similar patterns to controls in terms of expression type and comparable degrees of processing ease/difficulty. This trend and the significant age difference in performance between children and young adults with autism suggest that figurative language ability develops also in this population and that successful interventions can target specific skills and strategies for the improvement of figurative language ability (Melogno et al., 2017).

Few interventions target specifically figurative language in autism. They largely build on existing designs aimed at typically developing children or children with other developmental difficulties. For instance, Wiig (1989) provides some general instructions for teaching figurative language, such as metaphors. One way of doing this is for children to develop strategies for interpreting figurative language, such as using the context to help interpret the meaning of the phrase, in order to judge whether an expression is meant to be figurative or literal. This strategy was employed by Ezell and Goldstein (1992) in an intervention for idiom comprehension aimed at children with mild intellectual disability where idiom meanings were supported by visual props and introduced in either figurative or literal-biasing context. This type of intervention is consistent with Nippold (1991) who emphasized the role of context in idiom recognition for children with language impairment. She suggests that idioms should be presented in the context of stories and participating children can be asked questions highlighting the role of contextual support for the target interpretation of the idiom.

Persicke et al. (2012) are among the few studies which used intervention to enhance metaphor reasoning in children with autism. They aimed at evaluating the extent to which multiple exemplar training can support metaphor comprehension in children with autism by focusing on the features relevant for the target metaphor interpretation. This type of intervention is behavioral in nature and builds on exposing the child to multiple instances of the same phenomenon. The aim is to achieve a learned behavior and, in particular, the behavior of relating two things, which may be assumed to underlie metaphor creation and understanding. The intervention was efficient and led to generalization to untrained metaphors, however, the study included only three children with an autism diagnosis which makes it difficult to assess its validity for larger groups. Despite the exclusively behavioral approach, the study is important in that it confirms an important aspect of metaphor comprehension, namely the ability to establish conceptual links between the two referents in the metaphor expression by attending to features crucial for the analogy.

Mashal and Kasirer (2011) employed thinking maps to enhance metaphorical competence in children with autism. The study involved also children with learning disability and a control group for comparison. The learning disability group benefitted from the thinking maps more than the children with autism. In addition, different factors were associated with performance on the metaphor task in each group. Thus, in the autism group, the ability to generate different meanings of a homophone, which may be taken to indciate mental flexibility, correlated with novel metaphor understanding, while in the learning disability group, performance on this task correlated with the comprehension of conventional metaphors instead. These results highlight the importance of specifically targeted interventions depending on the participant group.

Future intervention designs can build on some of the attested strengths in autism. For instance, the advantage in non-verbal analogical reasoning documented in research (Morsanyi et al., 2020a) can be exploited for interventions targeting metaphor comprehension. Such designs, however, will need to take into account the verbal nature of metaphors,

which necessarily implies that verbal skills and vocabulary training will be necessary, and in particular one which targets semantic skills, along the lines of Melogno et al. (2017). Another factor which has been shown to interfere with the target understanding of non-literal language in autism is the overly literal interpretation, especially when the expression is decomposable and the idiom key competes with literal fillers in that position (Vulchanova et al., 2019a,b). Intervention designs can thus highlight the idiomatic nature of the expression and explain why a literal interpretation is impossible or not appropriate in this context.

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MV and VV wrote and edited the manuscript. Both authors contributed to the article and approved the submitted version.

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